Imaging with Coherent X-rays: From Technique Development to Single Particles

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The technique of Coherent X-ray Diffractive Imaging (CXDI) [1] utilizes algorithmic phase retrieval to generate an image of a sample using measured diffracted intensities. The achievable resolution is limited in principle only by the wavelength of the incident x-rays and the size of the detector used. It promises the ability to obtain a high-resolution image of any object, without the need for crystals. It will soon be two decades since the original demonstration of the use of coherent x-rays to image non-periodic objects [2]. Since this initial demonstration, a lot has changed in the world of x-ray science and not surprisingly, a lot of developments have taken place in the pursuit of high resolution coherent x-ray diffractive imaging.

Over the years, intense effort in algorithm development has made CXDI a fairly mature method that can now be employed in multiple fields such as biology [3] and condensed matter systems [4]. Scanning techniques have been developed allowing extended objects to be imaged. On overview if the CXDI technique and recent applications will be presented.

New x-ray sources are transforming x-ray science by enabling previously unachievable measurements to be performed. The new storage ring machines coming online will provide much increased coherent flux potentially allowing measurements that were previously signal-limited. Fourth generation light sources such as free electron lasers offer new and unique possibilities of limiting the radiation damage during the measurement [5] as well and unprecedented time resolution. The use of the CXDI technique with new x-rays sources will be presented, including time-resolved studies in materials [6] and developments towards using CXDI to image single particles, potentially single biological molecules [7].

References

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